Image Analysis and Chemometrics in Wastewater Treatment and Biotechnology

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Image analysis, coupled to multivariable statistical techniques, has been systematically applied, in the Centre of Biological Engineering, for monitoring both aerobic and anaerobic wastewater treatment processes, such as: aggregated and filamentous bacteria morphological determination and protozoa and metazoan identification in activated sludge; anaerobic granulation and deflocculating processes monitoring in anaerobic digesters.

With respect to the determination of the contents and morphology of aggregated and filamentous biomass in activated sludge, the main goal of the current research has been the characterization of bulking conditions, by image analysis biomass monitoring techniques [1]. In this sense, Wastewater Treatment Plant operating parameters have been correlated with biomass morphological parameters by Multivariable Partial Least Squares, in order to establish a robust procedure regarding the Sludge Volume Index estimation.

Another field of research has been the monitoring of the main protozoa and metazoan species in activated sludge, by means of semi-automated image analysis techniques, coupled to multivariable statistical techniques such as Neural Networks, Discriminant Analysis and Decision Trees [2]. It is known that the identification of protozoa and metazoan communities, in activated sludge, can be in valuable for a quick assessment of operational conditions such as the final effluent quality, aeration, sludge age and nitrification processes.

The monitoring of granule formation and deterioration processes is of the utmost importance regarding anaerobic wastewater treatment processes. For that purpose, image analysis techniques have been used to establish the mechanisms of granule formation and morphological characterization, in one hand, and allow the timely determination of granule deterioration phenomena.

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[2] Ginoris YP, Amaral AL, Nicolau A, Coelho MAZ, Ferreira EC, "Recognition of Protozoa and Metazoa using Image Analysis Tools, Discriminant Analysis, Neural Networks and Decision Trees", *Analytica Chimica Acta* (2007) **595**:160-169.